



Thesis proposal

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Evaluation of social interactions and physical activity of deaf people using a capture system

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Research units involved:

- Mitolab, Mitovasc Institute, UMR Inserm 1083 | UMR CNRS 6015, University of Angers
- LAUM UMR CNRS 6613, Laboratoire d'Acoustique de l'Université du Mans

Background :

Reduced hearing progressively leads to communication difficulties, such as poor comprehension, "off-tone" answers, or fatigue linked to the concentration required. These difficulties are exacerbated in noise. They progressively lead to isolation and even depression, which can be attributed to a change in social interaction as a result of the hearing loss. Hearing aids are the proposed solution for compensating hearing loss and improving comprehension in silence, as well as in noise. Nevertheless, the effects on communication and physical activity are only declarative, and no study has shown the contribution of hearing aids in this field.

The aim of the thesis is to develop a sound and physical activity capture prototype with a validated data analysis method to study and evaluate the social communication and physical activity of a person equipped with a hearing aid in everyday life.

State of the art :

Apart from recent studies of the effects of hearing aids on older people with presbycusis (age-related hearing loss), which focus on improving quality of life: reducing cognitive problems, the risk of dementia, depression and falls [1,2], to our knowledge, the direct and indirect impact of hearing aids on social behaviour and travel has not been directly and simultaneously addressed in a dedicated study. However, some studies have highlighted the difficulty of communication [3] and the need for people with hearing loss to maintain social interaction [4]. The interaction between ageing, hearing loss and the maintenance of posture, particularly in multi-tasking situations in everyday life, has also given rise to the **SAAMPres** collaborative project (**S**ocial interactions and **A**ctivities related to hearing **A**ids and **M**odification of the quality of life of the **P**resbycusis patient), which will be the outcome of this thesis project.

Methodology :

The evaluation of social communications requires🕒 the use of an on-board system for capturing information relating to the wearer(cephalic movements, speech) and its environment (noise, speech of thethe wearer (head movements, speech) and the wearer's environment (noise, speech

of interlocutors), initially under laboratory conditions and then in everyday life, processing this information to extract indicators that can characterise communication strategies and social interactions (frequency and duration of exchanges, effectiveness in exchanges, effectiveness in locating the other person, etc.) and posture (possible detection of movements to adapt to the communication situation), analysing the indicators obtained to produce a validated tool for assess the communication strategies and social interactions of a person with a hearing with or without a hearing aid.

Today, following work carried out by the LAUM laboratory over the last year and a half as part of a collaboration within the SAM network, a prototype eyewear frame equipped with seven MEMS microphones, a three-axis accelerometer-gyrometer and a data acquisition card is available. Initial studies to extract relevant information to qualify social interactions were initiated during two six-month 'student' projects at the Ecole Nationale Supérieure d'Ingénieurs du Mans.

Expected results and benefits :

- validated indicators to report on the state of social interaction and the activity of the wearer of the instrumented glasses,
- the implementation of effective algorithms for analysing the data supplied by the on-board system, for locating the interlocutor in everyday life in the presence of noise,
- the development of programmes to provide the desired information without storing the audio signals, thereby safeguarding users' privacy and complying with the RGPD,
- the development of a new autonomous, portable, miniaturised measurement system that can be fitted to any pair of spectacles to guarantee its acceptability, and which has the sensors (microphones and accelerometer) of the available prototype,
- analysing the data collected when patients use the sensor system.

The main objective of the project is to facilitate the acceptability of the device by patients in order to collect data enabling a detailed assessment of their social interactions, so as to be able to judge the improvement brought about by the equipment.

The results of the thesis work will be published in international journals and at conferences that will highlight the multidisciplinary nature of the thesis. All articles will be posted on HAL. The person recruited for the thesis will also offer a demonstration of the capture system at the Fête de la Science and at open days at the Universities of Angers and Le Mans. She will also be invited to take part in Ma thèse en 180s.

Provisional timetable for the thesis :

The thesis will be organised around the following tasks

- (1) development of a new system that can be fitted to a pair of glasses (LAUM),
- (2) Research into indicators to characterise social interactions (LAUM/MITOLAB and LPPL collaboration),
- (3) Measurement and validation sessions with the capture system (MITOLAB),
- (4) Analysis of the available data (LAUM/MITOLAB),
- (5) Development of the protocol required for the SAAMPres study (MITOLAB).

The person recruited for the thesis will divide his/her time between Le Mans and Angers depending on the tasks. Planning and progress meetings will be held every 15 days with all those

involved in the project. In addition to the thesis supervisors, specialists in ENT and acoustics will also be involved in developing analyses of signal processing, source location and on-board electronics.

References

- [1] Dawes P et al. Hearing loss and cognition: the role of hearing AIDS, social isolation and depression. PLoS ONE. 2015;10(3).
- [2] Livingston G, et al. Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. Lancet. 2020;396(10248):413–46.
- [3] Hughes S, et al. Social Connectedness and Perceived Listening Effort in Adult Cochlear Implant Users: A Grounded Theory to Establish Content Validity for a New Patient-Reported Outcome Measure – Ear Hear. 2018;39(5):922-934.
- [4] Smith S, et al. Age-related hearing loss and provider-patient communication across primary and secondary care settings: a cross-sectional study. Age Ageing. 2020;49(5):873–7.